(12) UK Patent Application (19) GB (11) 2 360 896 (13) A

(43) Date of A Publication 03.10.2001

(21) Application No 0007937.6

(22) Date of Filing 31.03.2000

(51) INT CL[7]
H04N 9/68

(52) UK CL (Edition S)
H4F FHHX

(56) Documents Cited
EP 0595301 A2 EP 0350794 A2

(58) Field of Search
UK CL (Edition R) H4F FCCF FGB FGC FHA FHHX
INT CL[7] H04N
ONLINE: EPODOC, JAPIO, WPI

(71) Applicant(s)
Sony United Kingdom Limited
(Incorporated in the United Kingdom)
The Heights, Brooklands, WEYBRIDGE, KT13 0XW, United Kingdom

(72) Inventor(s)
Stephen Mark Keating
Matthew Patrick Compton
Stephen John Forde

(74) Agent and/or Address for Service
D Young & Co
21 New Fetter Lane, LONDON, EC4A 1DA, United Kingdom

(54) Abstract Title
Image processing apparatus and method of processing images

(57) An image processing apparatus is arranged in operation to receive a colour image signal representative of a colour image. The colour image signal comprises first data representative of a first colour component of the image having light of at least one first wavelength, and second data representative of a second colour component of the image having light of at least one second wavelength. The content of the first and second data differ as a result of the size of the first and second image components differing with respect to each other. The image processor is arranged in operation to process the first and second data, in dependence upon the difference to the effect of increasing the size of the smaller of the first and second image components to the effect that the first and second components have substantially the same content. In an alternative arrangement, the size of the larger component is reduced and part of the corresponding data is repeated in correspondence with an amount by which the larger component has been reduced. The invention finds application with an optical imaging apparatus having a focusing lens which operates to produce images from light of any wavelength of both invisible and visible light spectra, such as a camera or a projector and to removing chromatic aberration caused by the lens.

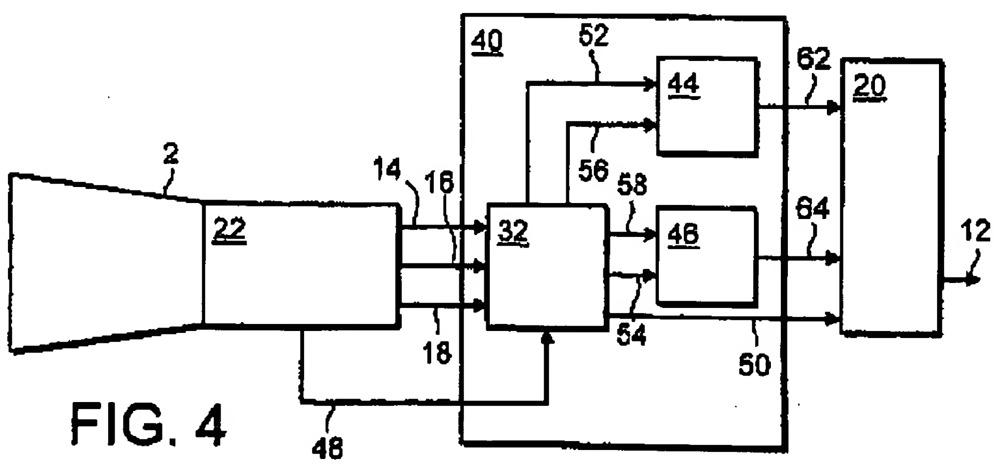

FIG. 4

GB 2 360 896 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

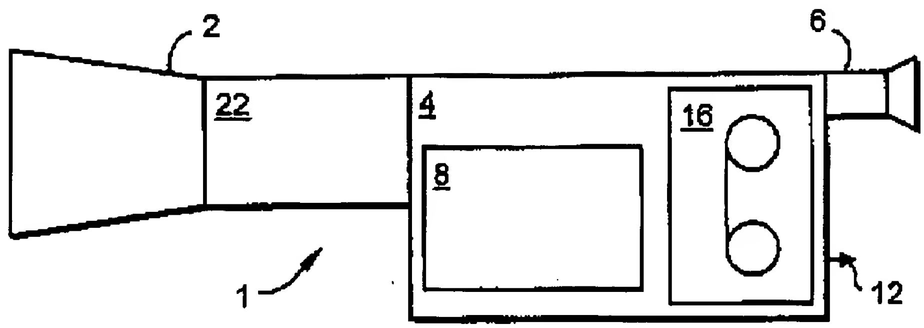

FIG. 1

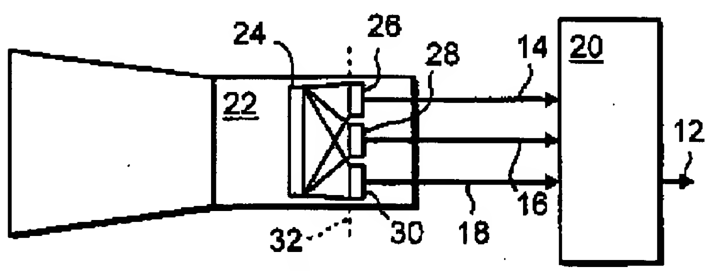

FIG. 2

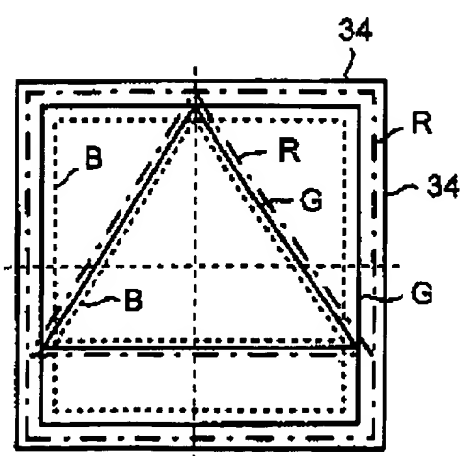

FIG. 3(A)

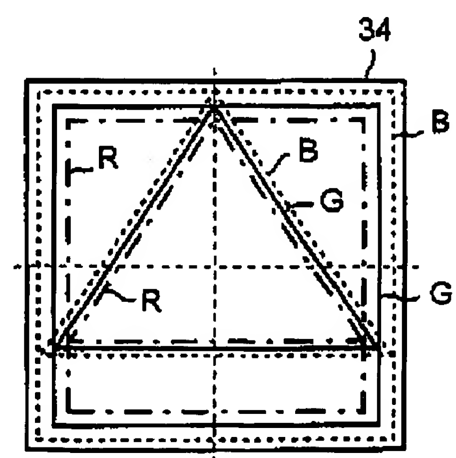

FIG. 3(B)

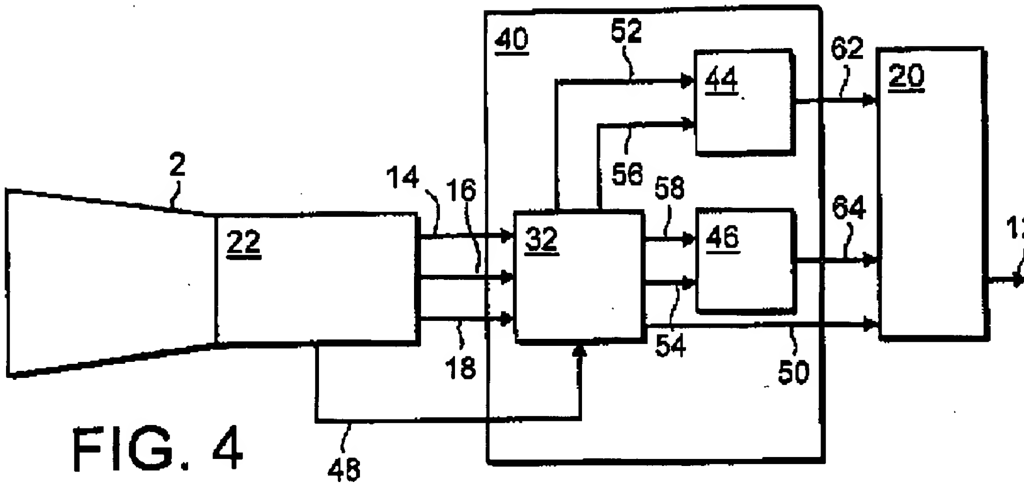
2
22
14
16
18
48
40
32
52
56
58
54
50
44
46
62
64
20
12

FIG. 4

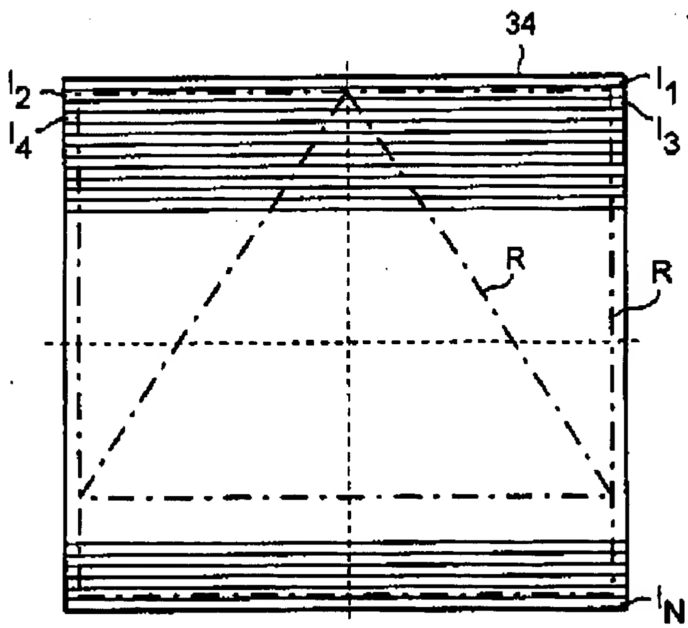
34
l_1
l_2
l_3
l_4
R
R
l_N

FIG. 5(A)

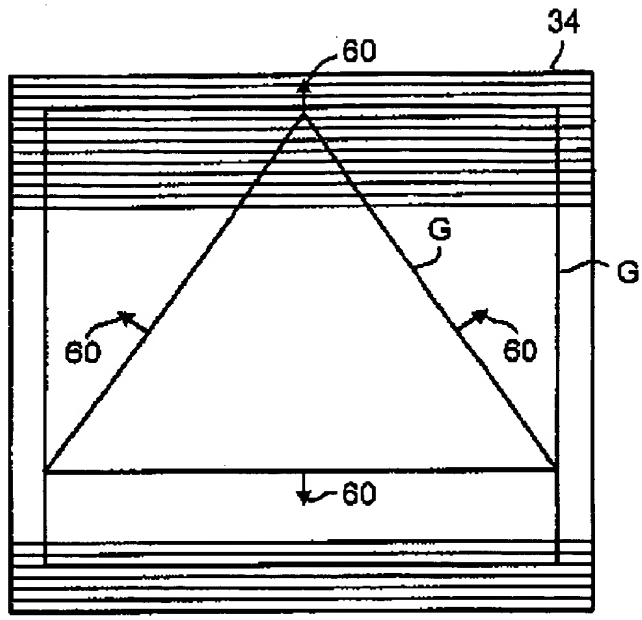

FIG. 5(B)

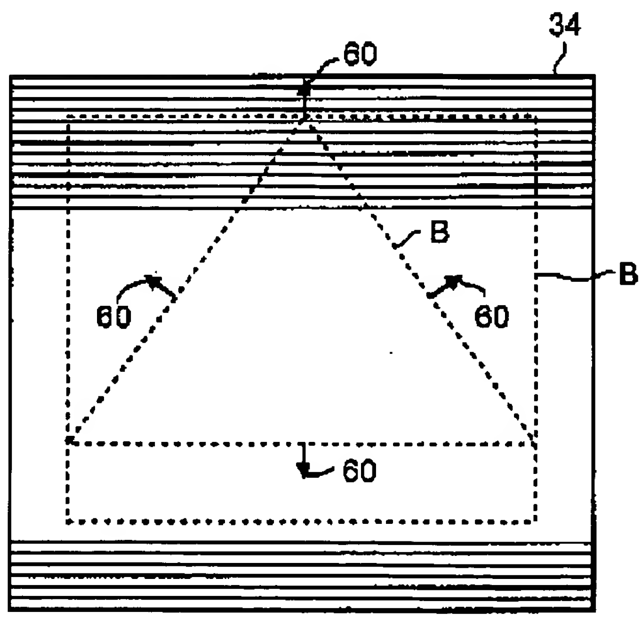

FIG. 5(C)

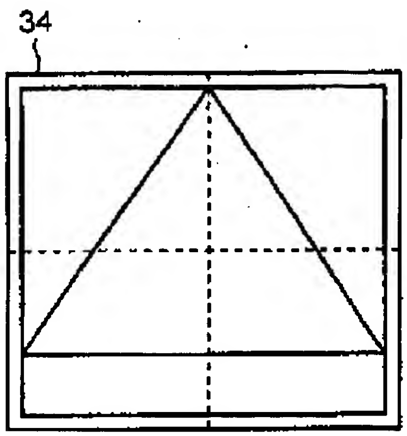

FIG. 6(A)

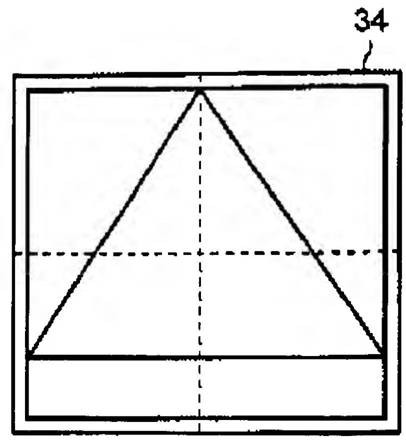

FIG. 6(B)

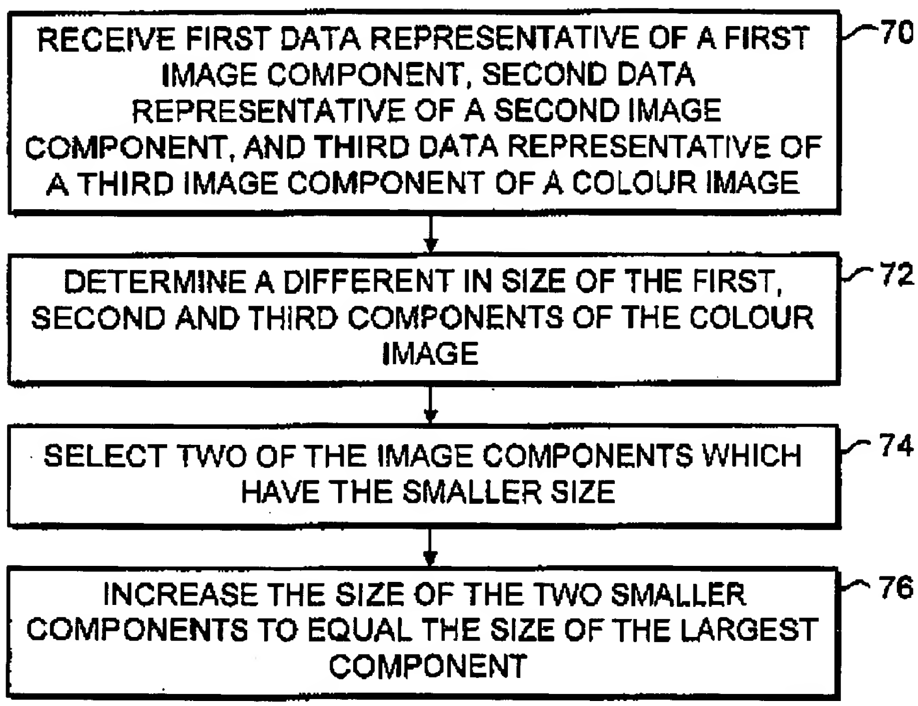

FIG. 7

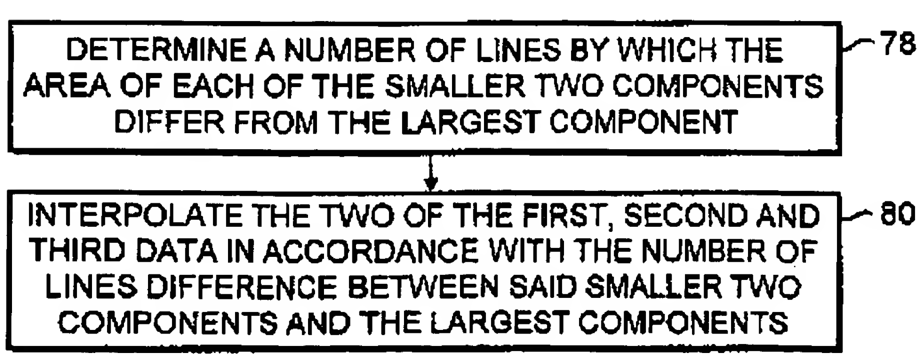

FIG. 8

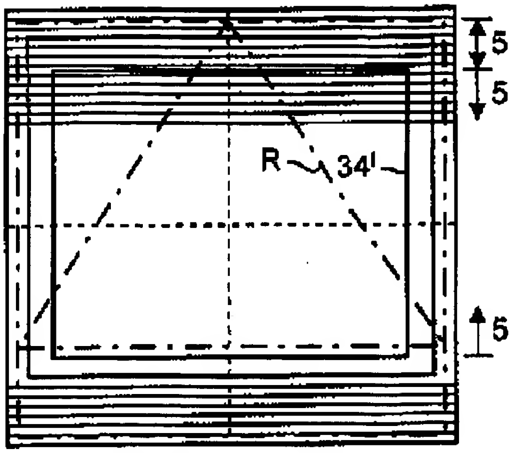

FIG. 9(A)

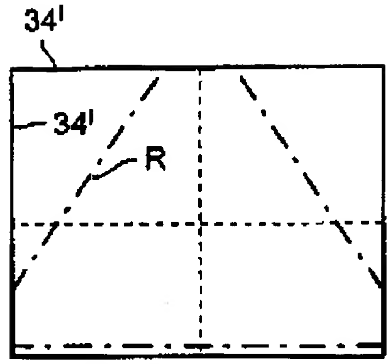

FIG. 9(B)

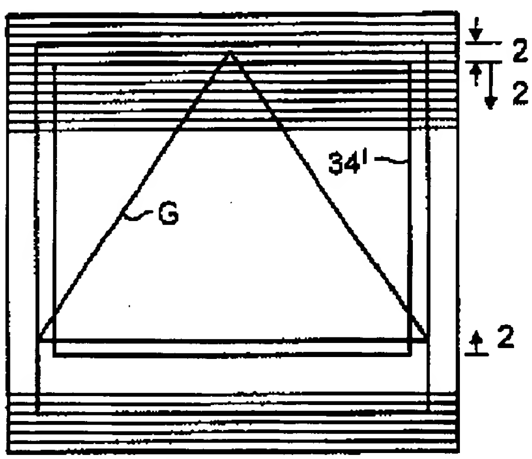

FIG. 10(A)

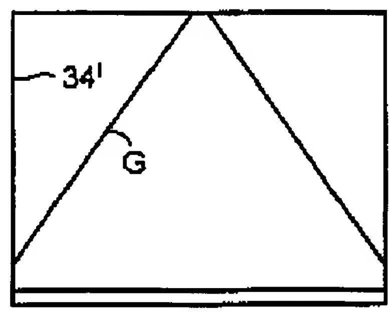

FIG. 10(B)

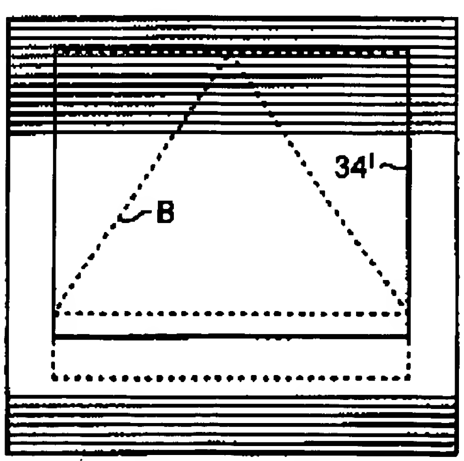

FIG. 11(A)

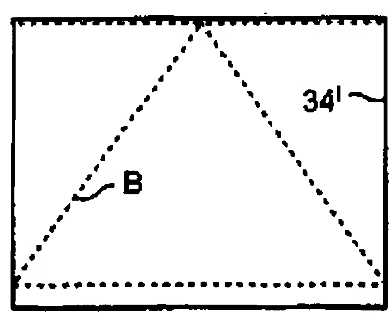

FIG. 11(B)

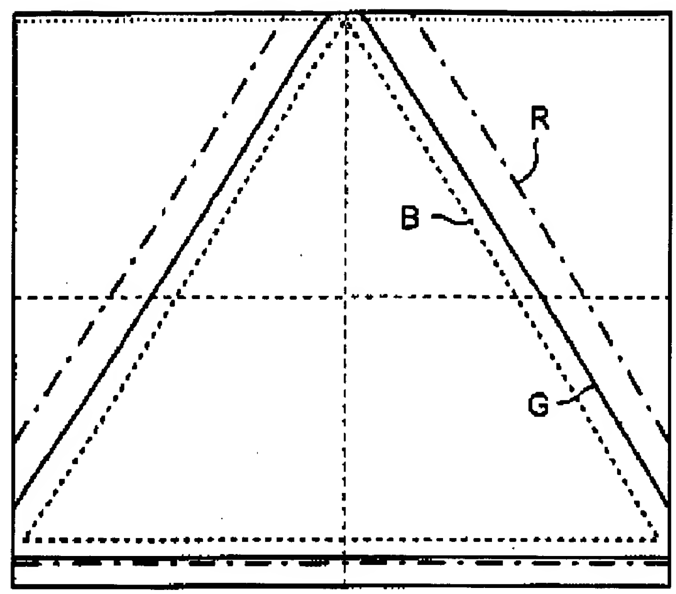

FIG. 12

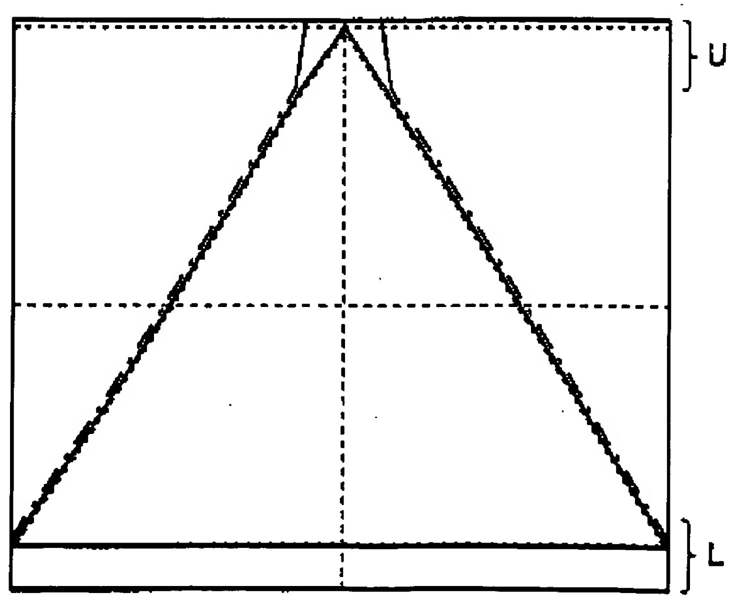

FIG. 13

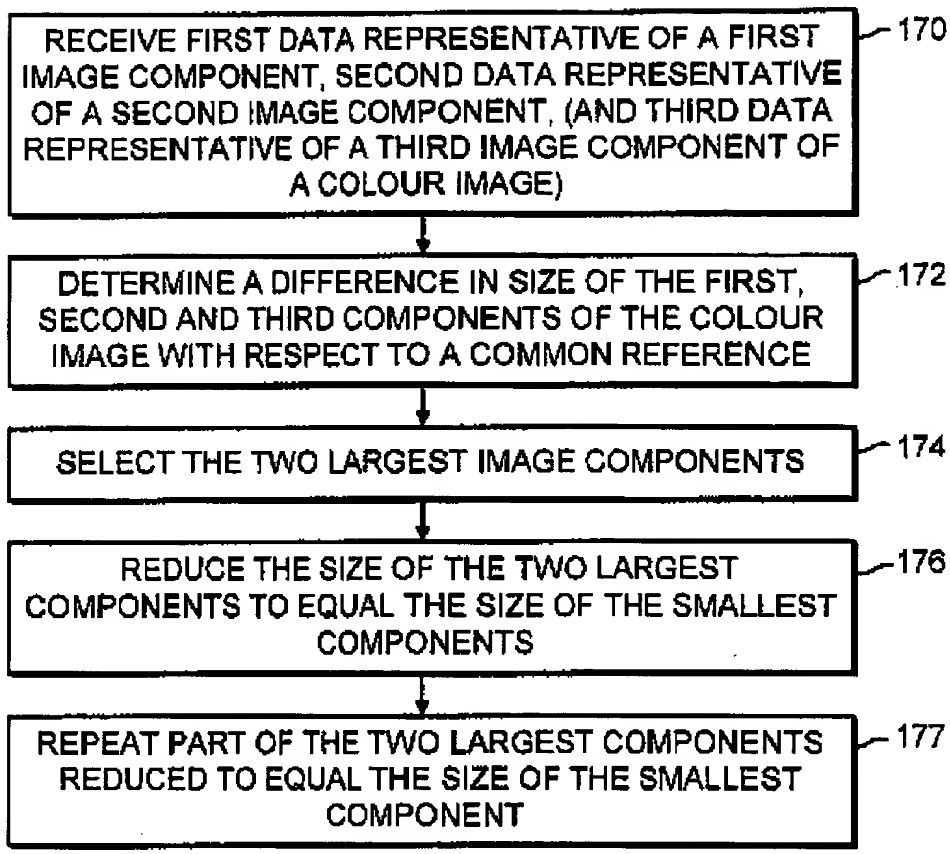
RECEIVE FIRST DATA REPRESENTATIVE OF A FIRST IMAGE COMPONENT, SECOND DATA REPRESENTATIVE OF A SECOND IMAGE COMPONENT, (AND THIRD DATA REPRESENTATIVE OF A THIRD IMAGE COMPONENT OF A COLOUR IMAGE)
170
DETERMINE A DIFFERENCE IN SIZE OF THE FIRST, SECOND AND THIRD COMPONENTS OF THE COLOUR IMAGE WITH RESPECT TO A COMMON REFERENCE
172
SELECT THE TWO LARGEST IMAGE COMPONENTS
174
REDUCE THE SIZE OF THE TWO LARGEST COMPONENTS TO EQUAL THE SIZE OF THE SMALLEST COMPONENTS
176
REPEAT PART OF THE TWO LARGEST COMPONENTS REDUCED TO EQUAL THE SIZE OF THE SMALLEST COMPONENT
177

FIG. 14

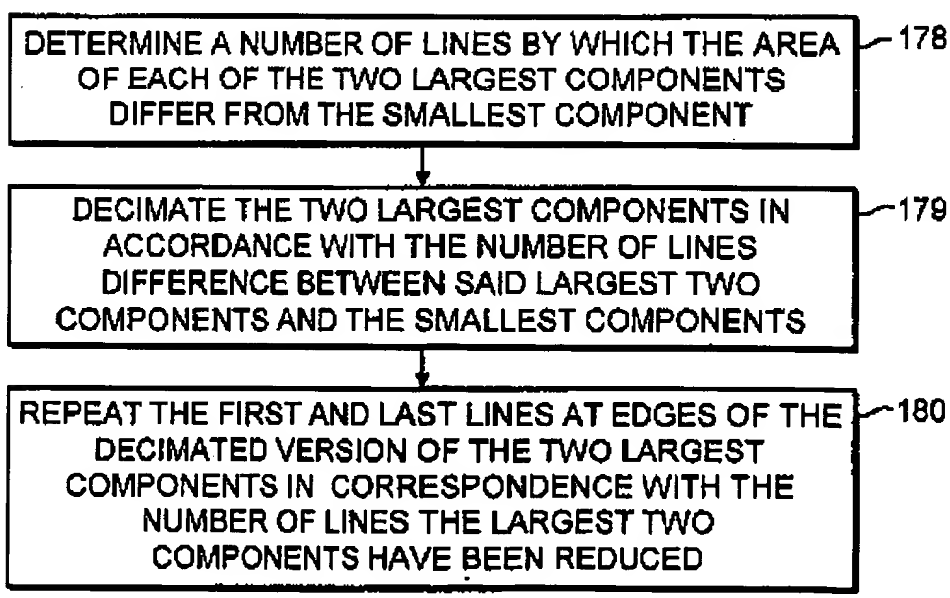
DETERMINE A NUMBER OF LINES BY WHICH THE AREA OF EACH OF THE TWO LARGEST COMPONENTS DIFFER FROM THE SMALLEST COMPONENT
178
DECIMATE THE TWO LARGEST COMPONENTS IN ACCORDANCE WITH THE NUMBER OF LINES DIFFERENCE BETWEEN SAID LARGEST TWO COMPONENTS AND THE SMALLEST COMPONENTS
179
REPEAT THE FIRST AND LAST LINES AT EDGES OF THE DECIMATED VERSION OF THE TWO LARGEST COMPONENTS IN CORRESPONDENCE WITH THE NUMBER OF LINES THE LARGEST TWO COMPONENTS HAVE BEEN REDUCED
180

FIG. 15

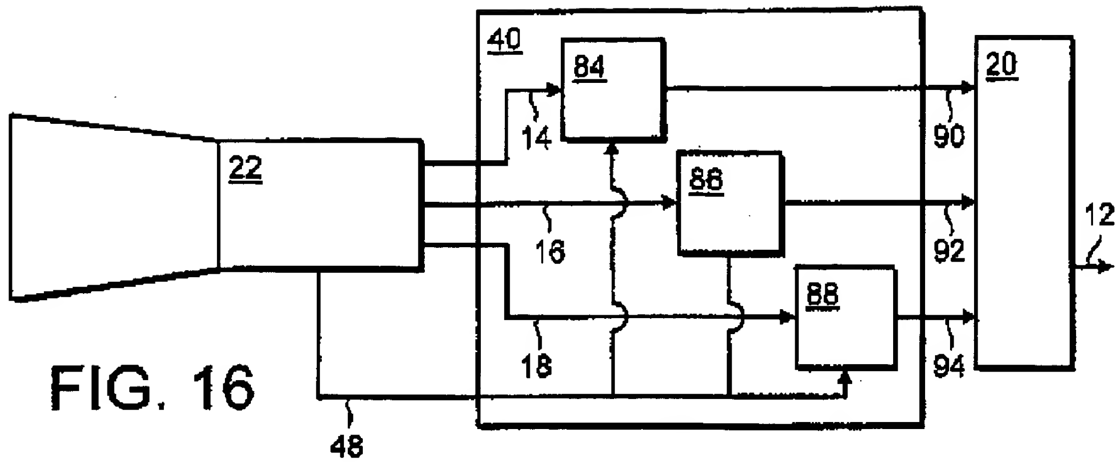

FIG. 16

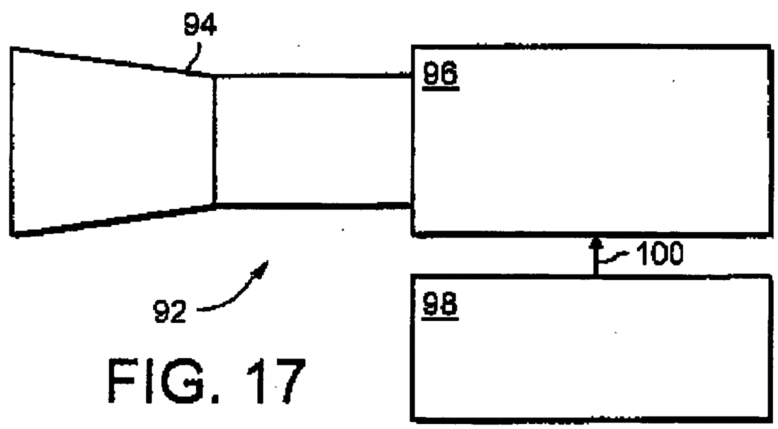

FIG. 17

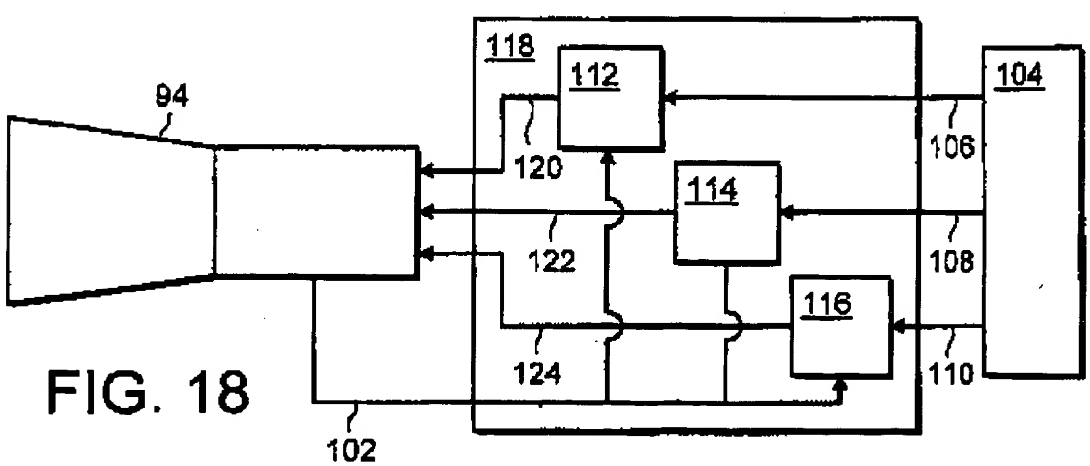

FIG. 18

IMAGE PROCESSING APPARATUS AND METHOD OF PROCESSING IMAGES

Field of Invention

The present invention relates to image processing apparatus and methods of processing images.

More particularly, but not exclusively, the present invention relates to image processing apparatus, which are arranged to form a colour image facilitated by an imaging lens, and methods of processing images formed by an imaging lens.

Background of the Invention

Cameras and light projectors are examples of optical imaging equipment which are provided with a lens in order to focus the light forming an image. For cameras, the imaging lens is provided in order to focus an image falling within the field of view of the lens onto a sensor. In the case of still image cameras such as digital cameras, camcorders, or television recorders, the sensor is provided with a dichroic element which serves to divide the colour image formed by the lens into red, green and blue components. The red, green and blue components are then sampled in order to produce a colour image signal representing data produced by sampling the red, green and blue components of the colour image. In the case of still image digital cameras, the data represented by the colour image signals are stored in order to be reproduced or processed in some way. In the case of television cameras, the colour signals may be recorded such as in the case of a video camera or camcorder, or communicated to a mixing or switching apparatus where for example the camera is used in a television production studio. Similarly however the camera may be a conventional camera in which the sensor is a film which is exposed to a predetermined amount of light produced from the image focused by the lens.

A further example in which a lens is used to form an image is a projector in which the projector provides the light source which is modulated in some way by an image, such as by introducing a coloured slide which is to be displayed.

In the above examples a lens is used in order to focus the image falling within a field of view of the lens.

As will be familiar to those skilled in the art, lenses do not form a perfect representation of the image falling within the field of view of the lens. This is because optical properties of the lens itself cause distortion in the focused image formed by the lens. One example of such distortion is chromatic aberration. Chromatic aberration arises from dispersion which is a property of the lens resulting from the refractive index of the material forming the lens, such as glass, differing with wavelength. There are two types of chromatic aberration which are; longitudinal aberration which corresponds to a tracking error; and a lateral aberration which corresponds to a registration error. The longitudinal chromatic aberration causes different wavelengths of light and therefore colours to focus on different image planes which are formed respectively along an axis of the lens at different distances from the lens. This produces a tracking error in that different colours of an image will be focused at different points or different image planes. Furthermore in a case of a zoom lens the amount of longitudinal chromatic aberration varies as the lens is zoomed and a relative position of the image planes on which different wavelengths or different colours of light is formed changes between a wide angle focus and a telephoto focus of the zoom lens. Lateral chromatic aberration occurs because the magnification of the image formed by the lens differs with wavelength. In the field of television this type of chromatic aberration is referred to as causing registration error which is produced because different wavelengths of light and therefore colours from a colour image will be focused at different points laterally displaced from the axis of the lens on an imaging plane.

It is known to provide a special type of lens known as a fluorite lens formed from a fluorite crystal in order to reduce chromatic aberration. However reducing chromatic aberration produced by an imaging lens within for example a television camera remains a technical problem. This is particularly so because fluorite is an expensive and relatively heavy material and in applications where the weight of the camera for example is important presents a disadvantage.

Summary of the Invention

According to the present invention there is provided an image processing apparatus arranged in operation to receive a colour image signal representative of a colour image, the colour image signal comprising first data representative of a first

colour component of the image having light of at least one first wavelength, and second data representative of a second colour component of the image having light of at least one second wavelength, wherein the content of the first and second data differ as a result of the size of the first and second image components differing with respect to each other, and consequent upon the difference the image processor is arranged in operation to process the first, second and third data to the effect of increasing the size of the smaller of the first and second image components to the effect that the first and second components have substantially the same content.

It is known to correct chromatic aberration at wavelengths associated with one colour component. Known techniques use, for example light having wavelengths corresponding to green light as a reference since the eye is most sensitive to green light. Therefore, known techniques process data generated from red and blue colour components in order to correct the chromatic aberration. As a result at least one of the other two colours which forms the image is reduced in size in order to meet the green component. However a technical problem has been recognised in that by reducing the size of the largest of the components demands that information beyond the outer edge of the largest component be introduced in order to produce the reduced version of the component. However this information beyond the outer edge of the colour image is absent. Therefore by providing an image processing apparatus to increase the two smallest colour components of the image the technical problem of providing information which is not available is ameliorated.

When light is referred to herein it will be understood that this refers to light of any wavelength of any form including both visible and invisible light. Although chromatic aberration has thus far been described with reference to a colour image having red, green and blue colour components it will be appreciated that invention is not limited to red, green and blue light, but is applicable to images composed of other colours and finds application to images composed of only two components, such as a composite image formed from an infra red component and a low intensity visible light component. It will therefore be appreciated that the word colour in this context refers to merely a component of an image associated with light having a band of wavelengths.

The difference in size of said first and second components may be as a result of a difference in the area of the first and second image components with respect to a common reference area, and the image processing apparatus may be arranged in operation to determine which of the first and second components have the smaller area, and consequent upon a difference in area between the smaller area and the larger area, to process the first or the second data to the effect of increasing proportionately the first or the second components of the colour image having the smaller area to the effect that the area of the first and second data is substantially the same.

Typically the imaging lens will be arranged to focus the colour image on to a sensor disposed at an imaging plane with respect to the imaging lens. Therefore at this plane which can be considered as a reference, the first and second image components will have different areas as a result of, for example, a chromatic aberration of the lens. Therefore advantageously the difference in size may be determined in accordance with a difference in the area of the first and second image components with respect to the common reference area which may be part of the sensor detecting the colour image.

In order to increase the size of the two smallest of the first and second components, the image processor may be arranged in operation to interpolate the first and second data corresponding to the two smaller components. Increasing the size of the smallest of the first and second components by interpolating the data is advantageous in that the new data is generated with reference to components of the image which already exist. In contrast, if the largest of the first and second components were to be reduced, then the largest component would have to introduce information which is not present in this component.

The first and second data may be representative of a number of lines from which the first, second and third components of the colour image are represented, the interpolating being performed to increase the smallest of the two components to equal the largest component in accordance with the difference in the number of lines.

In preferred embodiments, the first and second data may be represented as sampled components of the image which are produced as a number of lines, each line having a number of pixels. Therefore, in preferred embodiments the difference in the area of the first and second components will be represented as for example a difference

in the number of lines by which, for example an edge of the first component differs from the edge of the second component.

The colour image signal may comprise third data representative of a third colour component of the image having light of at least one third wavelength. the content of the third data differing from that of the first and second data as a result of the size of said third component differing from the first and second image components, and consequent upon the difference the image processor is arranged in operation to process the first, second and third data to the effect of increasing the size of the smallest of the first, second and third image components to the effect that the first, second and third components have substantially the same size.

In preferred embodiments the first component may correspond to red light. the second component may correspond to green light and the third component may correspond to blue light.

According to a first aspect of the present invention there is provided a camera according to Claim 15 of the appended claims.

Embodiments of the present invention can provide a camera having an imaging lens and a signal processing apparatus which operates to correct errors produced by the imaging lens caused by for example chromatic aberration. In such embodiments the image processing apparatus may be formed as a data processor executing appropriately encoded software. In preferred embodiments the camera may be a television camera or a video camera or the like. The present invention provides a particular advantage to television cameras and video cameras, and in particular, but not exclusively those which are arranged to generate high definition television and video images. By providing the image processing apparatus according to the present invention an improvement is provided to television cameras by correcting errors in the image produced by the lens such as for example those produced by a chromatic aberration of the imaging lens. This improvement may be recognised as two advantages. First the image processing apparatus may be embodied as a data processor so that an improved image is generated by the camera as a result of the image processing apparatus for a given quality of imaging lens. Furthermore, particularly for high definition television cameras errors produced by even the highest quality lens may be noticeable.

Therefore the image processing apparatus improves the errors which are produced by the imaging lens.

Embodiments can provide a digital camera such as a stills camera or a video camera in which the image processing apparatus is embodied.

According to a second aspect of the present invention there is provided an image generation apparatus according to Claim 18 of the appended claims.

As will be appreciated therefore embodiments of the present invention can provide an image generation apparatus such as a projector having an imaging lens which is arranged to focus an image produced by the projector onto a scene. Errors produced by the imaging lens may therefore be corrected by the image processing apparatus according to the present invention.

According to a third aspect of the present invention there is provided an image processing method comprising the steps receiving a colour image signal representative of a colour image, the colour image signal comprising first data representative of a first image component of light having at least one first wavelength and second data representative of a second image component of light having at least one second wavelength, wherein the sizes of the first and the second image components differ with respect to each other, and the method comprises the steps of processing the first or the second data corresponding to the smaller of the first and second image components to the effect of increasing the smaller component consequent upon the difference in size to the effect that the content of the first and second components are substantially the same size.

According to a further aspect of the present invention there is provided an image processing apparatus arranged in operation to receive a colour image signal representative of a colour image, the colour image signal comprising first data generated from a first colour component of the image having light of at least one first wavelength, and second data generated from a second colour component of the image having light of at least one second wavelength, the image processing apparatus comprising a control processing means and arranged in operation to determine an amount by which the content of the first and second data differ as a result of the first and second image components being different in size, and the first and second data being generated with respect to a common reference, and a data processing means

coupled to the control processor, which is arranged in operation to process the first data or the second data corresponding to the larger component to reduce the first data or the second data in accordance with the difference in size, and to repeat part of the first or the second data corresponding to the larger component in correspondence with an amount by which the larger component has been reduced.

Further advantageous features and aspects of the present invention are defined in the appended claims.

Brief Description of the Drawings

Embodiments of the present invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a schematic block diagram of a television camera,

Figure 2 is a schematic block diagram of parts of the television camera shown in figure 1,

Figure 3(a) is an illustrative representation of three components of a colour image formed by the imaging lens shown in figure 2, and Figure 3(b) is also an illustrative representation of components of a colour image formed by the imaging lens shown in figure 2,

Figure 4 is a schematic block diagram of a first arrangement of an image processor connected to the imaging lens shown in figure 2,

Figure 5(a) is a more detailed representation of a first image component of the colour image shown in figure 3(a), figure 5(b) is a more detailed representation of a second component of the colour image shown in figure 3(a), and figure 5(c) is a more detailed representation of a third component of the colour image shown in figure 3(a),

Figure 6(a) and Figure 6(b) are illustrative representations of the colour image components shown in figures 3(a) and 3(b) respectively after processing by the image processor shown in figure 4,

Figure 7 is a flow diagram illustrating the steps of the image processing method performed by the image processor shown in figure 4,

Figure 8 is a flow diagram illustrating further steps of the image processing method shown in figure 7,

Figure 9(a) is representation of a first component of the colour image shown in Figure 3(a) formed on a sensor with a reference frame. figure 9(b) is a representation of the first component of the image from which first data is produced by sampling.

Figure 10(a) is representation of a second component of the colour image shown in Figure 3(a) formed on a sensor with a reference frame, figure 10(b) is a representation of the second component of the image from which second data is produced by sampling,

Figure 11(a) is representation of a third component of the colour image shown in Figure 3(a) formed on a sensor with a reference frame, figure 11(b) is a representation of the third component of the image from which third data is produced by sampling,

Figure 12 is a representation of the first, second and third components as represented by the first, second and third superimposed on each other.

Figure 13 is a representation of the superimposed components shown in Figure 12, after the largest two components have been processed,

Figure 14 is a flow diagram illustrating the steps of the image processing method performed by the image processor shown in figure 4, according to a second embodiment of the invention,

Figure 15 is a flow diagram illustrating further steps of the image processing method shown in figure 14,

Figure 16 is a schematic block diagram of a second arrangement of an image processing apparatus connected to the imaging lens shown in figure 2,

Figure 17 is a schematic block diagram of an image projector, and

Figure 18 is a schematic block diagram of the parts of the image projector shown in figure 10 including an imaging processing apparatus according to an embodiment of the present invention.

Description of Preferred Embodiments

As already explained the present invention finds application in correcting distortion caused by the physical properties of an imaging lens within an item of optical imaging apparatus. The example embodiments of the present invention will be described with reference to the correction of errors caused by chromatic aberration

distortion. However the present invention is not limited to correcting such errors and may be provided to correct other distortion errors.

An example of an item of optical imaging equipment with which embodiments of the invention find application is shown in figure 1. In figure 1 a television camera 1 is shown to comprise an imaging lens 2 having a lens body 22 which is coupled to a camera body 4 and is arranged in operation to focus an image falling within a field of view of the imaging lens 2 onto a sensor within the body of the camera 4. The television camera is also provided with a view finder 6 which provides an operator with a view of the image focused by the imaging lens of the camera so that the operator may adjust the position, focus and other parameters of the camera in order to optimise the image representing a scene falling within the field of view of the imaging lens 2. Typically the sensor is arranged to generate colour image signals which may be displayed for example on a display means 8 to provide a further illustration of the colour image produced by the camera 1. The use of the display means 8 is more common on hand held video cameras such as domestic "camcorders". The television camera 1 may also include a tape drive 10 which is arranged to record the colour image signals or alternatively the colour image signals may be presented at an output channel 12 to be fed to a separate recording apparatus or a mixing studio. Parts of the television camera 1 which are particularly relevant for facilitating understanding of the present invention are shown in figure 2 where parts also appearing in figure 1 bear identical numerical designations.

In figure 2 the imaging lens 2 is shown to have three output channels 14, 16, 18 which are connected to a processing means 20 which represents all other processes performed by the television camera 1 such as presenting an image through the view finder, recording the colour image signals onto a tape 17 or presenting the colour image signals on the output conductor 12. The first, second and third output channels 14, 16, 18 are arranged to convey signals representative of first, second and third data respectively. The first, second and third data are representative of three colour components of the colour image formed by the imaging lens 2. Conventionally the first, second and third components are representative of red, green and blue light. The red, green and blue light components of the colour image are produced by a dichroic element 24, disposed at an imaging plane 32, embodied within the body of the imaging

lens 22 which divides the colour image into red, green and blue light components which are arranged to be detected by a corresponding sensor 26, 28, 30. The focus of the lens therefore takes into account the effect of the dichroic element 24, which is usually formed as a splitter prism, whereby the focus accommodates the refraction introduced by the prism. The sensors 26, 28, 30 are arranged in operation to sample the red, green and blue light components and to generate the first, second and third data which are produced and are representative of samples of pixels within each of a plurality of lines which make up the red, green and blue image components. Although in the example embodiment the first, second and third components are representative of red, green and blue light, the components may be representative of light of any wavelength both visible and invisible. Furthermore, the image may be comprised of only two components which suffer from chromatic aberration and are therefore of different sizes. An example of an application involving only two components is the processing of different image components produced from a camera from infra-red light and low intensity visible light, such as might be used as a security camera.

As will be appreciated from the explanation given above, the imaging lens 2 suffers from a chromatic aberration so that, at an imaging plane 32 at which the dichroic element is disposed, each of the red, green and blue image components will differ in size as a result of the distortion produced by the chromatic aberration of the lens. This is illustrated in a somewhat exaggerated way by the representation shown in figures 3(a) and 3(b).

In figure 3(a) a reference area represented by the solid square 34 provides an illustration of a detection area which can be utilised and is formed by the dichroic element 24 in combination with the sensors 26, 28, 30. As shown within the reference square 34 a red component of the image R is represented by a dot-dashed line as a square and within the square a triangle. Correspondingly, the green light component representing the same image is shown and illustrated by the solid line G whereas the blue light component is represented by the dotted line B. The same image is represented in Figure 3(b). However because the imaging lens 2 is a zoom lens, the representation in figure 3(a) is shown to illustrate a situation in which the zoom lens is set at a wide angle focus. Correspondingly, the representative figure 3(b) is representative of a zoom focus. In this focus, the blue light component now appears as

the largest of the three components, and the red light component now appears as the smallest of the three components. This is an illustration of a characteristic of chromatic aberration. The relative size of the different components with respect to the focus of the lens depends on the particular lens being used. In other examples, the red component could appear as the largest component, and the blue component the smallest component, or alternatively both the red and blue components could be smaller or larger than the green component. However in the present example it will be appreciated from the representations shown in figures 3(a) and 3(b) that the red, green and blue light components of the image differ in size as a result of the chromatic aberration. This can therefore be represented as a difference in area formed by the images within the common reference area illustrated by the reference frame 34 since the imaging lens will focus the colour image onto a two dimensional imaging frame formed on a sensor positioned at the imaging plane 32. The sensor is shown in figure 2 to comprise three CCD elements 26, 28, 30. However, the sensor could be formed from a single CCD element from which the three colour components are recovered.

The parts of the television camera 1 which are shown in figure 2 are reproduced in figure 4 together with a more detailed illustration of an image processing apparatus which operates to process the colour image signals to the effect of substantially removing the chromatic aberration. In figure 4 an image processing apparatus 40 is shown to comprise a control processor 42 and first and second data processors 44, 46. The first, second and third data are communicated to the control processor 42 via the first second and third connecting channels 14, 16, 18 which are coupled to three inputs of the control processor. Also shown connected to a further input of the control processor 42 is a control channel 48 which is arranged to convey control signals representative of a current focus position within a range of positions from wide angle to telephoto zoom provided by the imaging lens 2. However it will be appreciated that a chromatic error in the images signal providing a difference in size of the colour components may be derived from the colour image itself. In this case the control signals and the control channel 48 would not be required.

First Embodiment

In operation, according to a first embodiment of the invention, the control processor 32 is arranged to compare the first, second and third data by analysing the

lines of data representing the sampled red, green and blue images. The control processor operates to determine which two of the red, green and blue image components are the smallest and to determine an amount in terms of lines of the image by which the smallest components differ from the largest of the three image components. The first, second or third data representative of the largest of the components is then fed via a first output channel 50 directly to the further processor 20 as an output version of the colour image signals without being further affected. However, the two image components corresponding to those with smaller areas are fed respectively to the first and second data processors 44, 46 via two further output channels 52, 54. On two further output channels 56, 58, the control processor generates an indication of an amount by which the two smallest image components must increase in size in order to match the largest of the components presented at the output 50. The first and second data processors 44, 46 then operate to interpolate the first, second or third data in dependence upon which two of the three are representative of the smallest image components in order to increase the size of these components by the amount determined with reference to the largest component. This process of increasing the size of the two smallest components is illustrated by the representation of the three components shown in figures 5(a), 5(b) and 5(c) which illustrate on a larger scale the image formed within the common reference shown in figure 3(a).

In figure 5(a) the red component of the colour image is shown superimposed on a sensor array representative of the sensor 26. The array is provided with a plurality of lines l_1 l_2 to l_N on which the red component falls. Each of the lines l_1 to l_N includes a plurality of samples each of which represent a pixel value so that in combination with all the other lines l_1 to l_N the first data representative of the red image component R is generated. Similarly in figures 5(b) and 5(c) the blue and green components are respectively shown with reference to the common reference square 34 as projected respectively on to the image component sensors 28, 30. As represented in figures 5(a), 5(b) and 5(c), the green and blue components are both smaller than the red component which represents the largest component. Therefore in order to match the red component, the second and third data are interpolated to the effect of increasing the size of the green and blue components to match that of the red component. As illustrated for example in figure 5(b), the green component is smaller than the red

component by approximately three lines and the blue component is smaller than the red component by approximately five lines. Therefore, as indicated by the arrows 60, the green and blue images are increased in size by adding correspondingly three and five lines of data and correspondingly expanding the image horizontally and interpolating with respect to the second and third data generated by sampling the green and blue images as shown in figures 5(b) and 5(c) in order to produce a larger version of these image components whilst being consistent with the band width and the content of the image.

The adapted versions of the second and third data are therefore presented and conveyed to the further processor 20 via connecting channels 62, 64. Together with the first data formed on the output channel 50 the second and third data form corrected colour image signals in which the distortion caused by the chromatic aberration is substantially reduced. In accordance with the operation of the example embodiment of the invention shown in figure 4, the effect on the colour image shown in the representation in figures 3(a) and 3(b) is reproduced in figures 6(a) and 6(b) which now show that the three components of the colour image are matched to the effect that the distortion introduced by the chromatic aberration has been substantially reduced.

A flow diagram illustrating the operation of the image processing apparatus 40 is shown in figure 7. In figure 7, a first step in the process 70 is to receive the first data second data and third data representative respectively of the first, second and third components of a colour image. The first, second and third components therefore each correspond to light of a band of wavelengths and as will be appreciated, these wavelengths could be any of a range of possibilities. At step 72 the process then operates to determine a difference in size of the first, second and third components of the colour image. Consequent upon the difference in size, the third step 74 operates to select the two image components which have the smaller size. Correspondingly therefore, the fourth step 76 represents a process step in which the two smallest components are increased in size so that their size equals that of the largest component. The operations of the process step 76 are further illustrated by the further flow diagram shown in figure 8. In figure 8 the first process step 78 is to determine a number of lines by which an area of the smaller of the two components differs from the largest component. This is followed by a further process step 80 in which two of the first,

second and third data are interpolated in accordance with the number of lines difference between the smallest two components and the largest component to the effect that the first, second and third images represented in the example embodiment as red, green and blue light are substantially matched to each other.

Second Embodiment

The operation of the control processor 32 in accordance with a second embodiment of the present invention will now be described with reference to figures 9, 10 and 11. Figures 9, 10 and 11 provide a representation of the three imaginary components shown in figure 3(a) as formed on the sensors 26, 28, 30. However unlike the representation shown in figure 5 and figure 3(a), the area of the sensor, from which the image component can be sampled, is smaller than two of the image components focused on to the sensor. This is as a result of the chromatic aberration of the imaging lens. These components are shown in figures 9(a) and 10(a). The area from which the image component can be sampled is represented in each of figures 9(a), 10(a) and 11(a) as a solid line reference frame 34'. By sampling the image component formed within the reference frame 34', data representative of this sampled image component is formed. For each of the three components, a representation of the result of sampling the image component within the reference frame 34' is shown respectively in figures 9(b), 10(b) and 11(b). As will be seen from the sampled image versions which form the first, second and third data, the largest component which corresponds in this example embodiment to the red component and the second largest component which in this example embodiment corresponds to the green component do not match the content of the smallest image component which in the example embodiment is formed from the blue component represented in figure 11(b). This is caused by the chromatic aberration of the imaging lens. As a result, in order to process the red and green components shown in figures 9(b) and 10(b) the first and second data which represent these sampled image components are processed to the effect of reducing the size of these components, and then repeating parts of these image components at the first and last lines so that the content of each of these image components matches substantially that of the blue component shown in figure 11(b).

In operation according to the second embodiment, the control processor 32 determines which two of the three image components are the largest. This is derived

from the control signals representative of the current focus of the lens 22. The focus of the lens is therefore interpreted in accordance with a predetermined relationship of focus against chromatic distortion of the colour image so that the control processor 32 can derive from the control signals, which of the components represent the two largest components. The smallest component is then fed via the first output channel 50 directly to the further processor 20 as an output component of the colour image signals without being further affected. However the two largest image components, which are the red and green components shown in figures 9(b) and 10(b), are fed respectively to the first and second data processors 44, 46 via the two further output channels 52, 54. The first and second data processors 44, 46 then operate to decimate the first and second data in dependence upon the amount by which the two largest components is greater than the smallest component. The effect of decimating the two largest components is better illustrated with reference to figure 12 and figure 13. In figure 12 the three sampled image components shown in figures 9(b), 10(b) and 11(b) are superimposed. This provides an illustration of the relative difference in content produced by sampling the image components which differ in size. As shown in figures 9(a) and 10(a), the red component differs from the blue component by approximately five lines. This is represented in figure 9(b) as the apex of the triangle being approximately five lines outside the upper edge of the reference frame 34'. Correspondingly in figure 10(a) the green component is approximately two lines greater than the reference frame 34'. Therefore in operation the first and second data processors 44, 46 decimates the first and second data to the effect of reducing the size of the red and green components by respectively five and two lines. The result of the reduction process is illustrated in figure 13. However as a result of the reduction, the reduced red and green image components are now missing information at the upper and lower edges U, L of each of the colour image components. This is because that part of the triangle shown in figures 9(a) and 10(a) for the red and green components did not form part of the sampled image component corresponding to the first and second data, because these parts U, L of the image component fell outside the reference frame 34'. Therefore in order to provide the reduced sampled image components with substantially the same content as the smallest component which in this example is the blue component, the first and last lines of each of the first and

second data components is repeated after decimation in accordance with the number of lines by which these components were reduced. Thus, for the red component the first and last lines are repeated five times whereas for the green components the first and last lines are repeated twice. After decimation and repetition of the first and last lines, the two processed components as represented by the first and second data will be as shown in figure 13. In figure 13, it will be seen that in an exaggerated way the upper and lower edges of the image do not exactly match the smallest component. However as will be appreciated by repeating the data in the last line of each of the largest image components, the content of each of the red, green and blue image components represented by the first, second and third data are substantially matched to one another.

As with the first example embodiment the colour image has three components. However it will be understood that the second embodiment can also operate with only two components of an image which may not be coloured. In this case with only two components the control processor 32 must merely decide which of the two components is the larger and perform the decimation and repetition operations in order that the two components have substantially the same content.

In summary the operation of the control processor 32 according to the second example embodiment of the present invention is illustrated by the flow diagram provided in figure 14.

In figure 14, the first process step 170 represents the control processor receiving the colour image signals representative of the first data, second and third data. Although the second embodiment of the invention has been described with reference to the colour image signal representative of three components, as mentioned above, the colour image may comprise only two components. Correspondingly the third data may be considered optional. In the second processor step 172 the control processor determines from the control signals from the imaging lens which two of the red, green and blue components are the largest with respect to the reference frame 34' and an amount by which the two largest components are larger than the smallest component. In process step 174 the two largest image components are selected and in process steps 176 the two largest image components are reduced in size so as to equal the size of the smallest component. In process step 177 parts of each of the largest components after being reduced are repeated in accordance with the amount by which

each of the components has been reduced, to the effect of matching the content of the reduced components to that of the smallest components.

The image processing method according to the second embodiment may also include further process steps as described for the first example embodiment of the invention. These process steps are illustrated in figure 15. In figure 15 process step 172 further includes process step 178 in which a number of lines by which the area of each of the two largest components differ from the smallest component is determined. Therefore correspondingly process step 176 includes the step 179 in which the size of the two largest components is reduced by decimating the data representative of the two largest components in accordance with the number of lines difference between the two largest components and the smallest component. Furthermore the step of repeating part of the two largest components represented as step 177 in figure 14 includes the step 180 of repeating the first and last lines at the edges of the decimated version of the two largest components in correspondence with the number of lines the largest two components have been reduced.

Further Embodiments

Although in the second example embodiment of the invention both the two largest components have been reduced in size with reference to the smallest component, it will be appreciated that in other embodiments of the invention one of the largest component could be reduced in size whereas the smallest component could be increased in size in accordance with the first embodiment of the present invention. In this case, the component which is neither the smallest or the largest would remain the same and would be fed through to the further processor 20 via the output conductor 50.

A further example of an arrangement of the image processor 40 according to the first example embodiment of the present invention is shown in figure 16. In figure 16 the image processing apparatus 40 is shown to comprise first, second and third data processors 84, 86, 88. As shown in figure 16, the control channel 48 is fed to each of the first, second and third data processors 84, 86, 88. The connecting channels 14, 16, 18 which convey respectively the first, second and third data are each respectively fed to an input of the first, second and third data processors. In operation the first, second and third data processors are dedicated to process the first, second and third data representative of the red, green and blue image components of the colour image. As

with the embodiment shown in figure 4, the control signals are interpreted by each of the first, second and third data processors to determine in dependence upon the current focus setting of the image lens 2 whether the image component to which the data processor is dedicated should be increased in size or should be passed unprocessed to the output conductors 90, 92, 94 because the image component is the largest of the image components. Correspondingly, two of the data processors 84, 86, 88 which are associated with the two smallest components are arranged in operation to interpolate the data in order to increase the size of the image to match that of the largest image component. The relative size of the images is determined from the control signals which may provide an absolute difference between the red, green and blue components of the image. Alternatively, the control signals may provide a current setting of the focusing lens and the data processors may include a data store in which a profile of the chromatic aberration of the lens is represented in terms of the amount by which the size of the respective image components differ in dependence upon the current setting of the lens. Therefore in combination the control signals and the information stored in the data store provide the respective data processors with an amount by which the image components should be increased or not as the case maybe. Thus, the second arrangement of the image processing apparatus 40 as shown in figure 16 represents an alternative arrangement to that shown in figure 4. Although the arrangement shown in Figure 16 has been described with reference to the first embodiment, it will be understood that the image processor 40 as shown in figure 16 will also find application with the second embodiment of the present invention. Again the first, second and third data are fed respectively to a the first, second and the third data processors 84, 86, 88 and processed in accordance with the control signals 48. However a repetition of the explanation of this arrangement of figure 16 for the second embodiment is unnecessary as it will be understood from the above description of the first embodiment how this arrangement correspondingly operates for the second embodiment.

Although the relative difference in size of the components of the image as described above has been represented as a difference in area, it will be understood that in certain applications, this size could be represented in one dimension. An example of such an application is in a Tele-cine camera film to video converter. With this application the video camera has a special CCD having only a single line of pixels. As

such the sampled components will effectively represent a one dimensional representation.

As will be appreciated by those skilled in the art. although the example embodiment of the present invention has been described with reference to a camera which may be a television camera, a video camera or a camcorder. or indeed a stills digital camera, the present invention also finds application with an optical imaging apparatus which is arranged to project or create an optical version of an image. An example of such an optical image generation apparatus is a projector. An example representation of a projector is shown in block diagram form in figure 17.

In figure 17 a projector 92 is shown to comprise an imaging lens 94 and a projector body 96. Connected to the projector 92 is a source of imaging signals such as a personal computer or a television receiver which operates to generate colour image signals which are fed via a connecting channel 100 to an input of the projector 92. In operation the projector body 96 has a light source which is modulated in accordance with the colour image signals fed via the connecting channel 100. Parts of the projector shown in figure 17 are shown in figure 18 connected to a further example arrangement embodying of the present invention. In figure 18 the imaging lens is shown to have a control channel 102 which generates control signals representative of a current focus setting of the imaging lens 94. The control channel and control signals can substantially correspond to the control channel 48 shown in the first and second embodiments of the invention shown in figures 4 and 9. A source of a colour image 104 is shown to have three output channels 106, 108, 110 which serve to convey to first, second and third data processors 112, 114, 116, first, second and third data representative of red, green and blue components of the colour image signals. As for the example embodiment shown in figure 16, the image processing apparatus according to the further example embodiment of the present invention 118 operates to reduce distortion errors as a result of for example chromatic aberration caused by the imaging lens 94 of the projector. To this end, the control signals fed via the control channel 102 to the first, second and third data processors serve to provide an indication of the current setting of the imaging lens 94. Depending on this setting the data processors operate to determine which two of the red, green and blue images have the smallest or largest sizes, in dependence on which of the first and second example

embodiments of the present invention are implemented. Consequent upon the difference between the sizes of these images and that of the largest or smallest of the components, the data processors 112, 114, 116 operate to interpolate or to decimate the data representative of the components in order to match the size of the largest or smallest component. The corrected version of the colour image signals are therefore presented at three inputs 120, 122, 124 of the imaging lens 94 and arranged to modulate the light source of the projector (not shown).

A further example of an application of the present invention is in the correction of colour film, which has suffered from ageing effects. These effects shrink the colour components of the film image by different amounts. Therefore by applying the image processing method and apparatus as described in the second example embodiment these ageing effects can be substantially corrected.

As will be appreciated the example embodiments of the invention described above are not limiting and the invention includes equivalents and further arrangements whilst still falling within the scope of the present invention. Furthermore, the invention finds application in correcting any form of chromatic error, which may be caused for example by a focusing lens which operates to produce any kind of image having components derived from any kind of invisible or visible light.

CLAIMS

1. An image processing apparatus arranged in operation

- to receive a colour image signal representative of a colour image. said colour image signal comprising

- first data representative of a first colour component of said image having light of at least one first wavelength, and

- second data representative of a second colour component of said image having light of at least one second wavelength, wherein the content of said first and second data differ as a result of the size of said first and second image components differing with respect to each other, and consequent upon said difference said image processor is arranged in operation

- to process said first and said second data to the effect of increasing the size of the smaller of said first and second image components to the effect that said first and second components have substantially the same content.

2. An image processing apparatus as claimed in Claim 1, wherein the difference in size is as a result of a difference in the area of said first and second image components with respect to a common reference area, and said image processing apparatus is arranged in operation

- to determine which of said first and second components have the smaller area, and

- consequent upon a difference in area between the smaller area and the larger area, to process said first or said second data to the effect of increasing proportionately said first or said second components of said colour image having the smaller area to the effect that the area of said first and second data is substantially the same.

3. An image processing apparatus as claimed in Claim 1 or 2, wherein said image processor is arranged in operation to process said first and said second data to the effect of increasing proportionally the size of said smaller of said first and second components by interpolating said first or said second data corresponding to said smaller component.

4. An image processing apparatus as claimed in Claims 1, 2 or 3, wherein said first and second data are representative of a number of lines, said interpolating being performed to increase the smaller component to equal the larger component in accordance with said difference in said number of lines.

5. An image processing apparatus as claimed in Claim 4, wherein said colour image signal comprises

- third data representative of a third colour component of said image having light of at least one third wavelength, the content of said third data differing from that of said first and second data as a result of the size of said third component differing from said first and second image components, and consequent upon said difference said image processor is arranged in operation

- to process said first, second and third data to the effect of increasing the size of the smallest of said first, second and third image components to the effect that said first, second and third components have substantially the same size.

6. An image processing apparatus arranged in operation to receive a colour image signal representative of a colour image, the colour image signal comprising

- first data representative of a first colour component of the image having light of at least one first wavelength,

- second data representative of a second colour component of the image having light of at least one second wavelength, and

- third data representative of a third colour component of the image having light of at least one third wavelength, wherein the content of said first, second and third data differ with respect to each other as a result of the size of the first, second and third image components differing with respect to each other, and consequent upon the difference the image processor is arranged in operation to process at least two of said first, second and third data to the effect of increasing the size of the smallest two of the first, second and third image components to the effect that the first, second and third data have substantially the same content.

7. An image processing apparatus as claimed in Claim 6, wherein the difference in size of the first, second and third components is as a result of a difference in the area of the first, second and third image components with respect to a common reference area and the image processing apparatus is arranged in operation to determine which two of the first, second and third components have the smallest areas and consequent upon a difference between the area of each of the two smallest areas and the largest area of the components, to process two of said first, second and third data to the effect of increasing proportionally the two of the first, second and third components of the colour image corresponding to the smallest areas to the effect that the content of the first, second and third data is substantially the same.

8. An image processing apparatus as claimed in Claim 6 or 7, wherein said image processor is arranged in operation to process two of said first, second and third data to the effect of increasing proportionally the size of said smallest two of said first, second and third components by interpolating said first, second or third data corresponding to said smallest two components.

9. An image processing apparatus as claimed in Claims 6, 7 or 8, wherein said first, second and third data are representative of a number of lines, said interpolating being performed to the effect of increasing the smallest two components to equal the largest component in accordance with said difference in said number of lines.

10. An image processing apparatus as claimed in any of Claims 1 to 4, comprising a first data processor and

a control processor arranged in operation to receive a control signal, and said first and second data, wherein said control signal is indicative of an amount by which the smaller of said first and second components of said colour image differ with respect to the larger of said first and second image components, and said control processor is arranged in operation

- to feed said first and said second data corresponding to said smaller component to said first data processor respectively,

- to communicate to said first data processor an amount by which said two components of said image differ, and said first processor is arranged in operation

- to process said first or said second data to the effect of increasing the size of said smaller component by interpolating said data representative of said smaller image component until said smaller component substantially matches the content of said larger component.

11. An image processing apparatus as claimed in any of Claims 5 to 9, comprising a first data processor and a second data processor and

a control processor arranged in operation to receive a control signal, and said first, second and third data, wherein said control signal is indicative of an amount by which the two smallest of said first, second and third components of said colour image differ with respect to the largest of said first, second and third image components, and said control processor is arranged in operation

- to feed two of said first, second and third data corresponds to said two smallest components to said first and second data processors respectively,

- to communicate to said first and second data processors an amount by which said two components of said image differ from said largest component, and said first and second processors are arranged in operation

- to process said two of said first, second and third data to the effect of increasing the size of said smallest two components by interpolating said data representative of said two smallest image components until said smaller two components match substantially the content of said largest components.

12. An image processing apparatus as claimed in any of Claims 1 to 4, comprising a first data processor and a second data processor each being arranged respectively to receive said first and second data, and a control signal indicative of a relative size of said first and second colour image components, and consequent upon said control signal one of said first and second data processors is arranged in operation to interpolate respectively the corresponding first and second data to the effect of increasing the size to match substantially said larger of said image components.

13. An image processing apparatus as claimed in any of Claims 5 to 9, comprising a first data processor, a second data processor and a third data processor each being arranged respectively to receive said first, second and third data, and a control signal indicative of a relative size of said first, second and third colour image components, and consequent upon said control signal two of said first, second and third data processors are arranged in operation to interpolate respectively the corresponding first, second and third data to the effect of increasing the size of the components to match substantially the content of said largest of said image components.

14. An image processing apparatus as claimed in any of Claim 5 to 9, 11, 13, wherein said first, second and third image components correspond substantially to red, green and blue light components.

15. A camera comprising an imaging lens, and an image processing apparatus as claimed in Claim 14, wherein said imaging lens is arranged in operation to generate first, second and third signals representative of the red, green and blue components of a colour image formed within a field of view of said imaging lens, and said image processing apparatus is arranged in operation to receive said first, second and third signals, and to process said signals to the effect of increasing the size of two of said red, green and blue components which are smaller than the largest of said components to match substantially the content of said largest component.

16. A camera as claimed in Claim 15, wherein said lens is arranged in operation to generate control signals indicative of an amount by which said two smallest components differ from said largest component, and said image processing apparatus is arranged in operation to receive said control signal, which is representative of a chromatic aberration error of said lens, said image processing apparatus being arranged in operation substantially to correct said error by said matching of said two smallest components to said largest of said components.

17. A camera as claimed in Claims 15 or 16, comprising a dichroic component or at least one colour filter arranged in operation to receive light from said imaging lens

and to separate said light into red, green and components, and an image sampling means, arranged in operation to receive said red. green and blue components to generate said first, second and third data by sampling said red, green and blue light components.

18. An image generation apparatus, comprising an image generator configured in operation to generate first, second and third data representative of red, green and blue components of a colour image, and an image processing apparatus as claimed in Claim 14 arranged in operation to receive said first, second and third data, and to process said data to the effect of increasing increase the size of two of said red, green and blue components which are smaller than the largest of said components to match said largest component.

19. An image generation apparatus, comprising an image generator configured in operation to generate a colour image and an image processing apparatus as claimed in Claim 14, wherein said imaging generation apparatus is arranged in operation to generate first, second and third data representative of red, green and blue components of the colour image, and said image processing apparatus is arranged in operation to receive said first, second and third signals, and to process said signals to the effect of increasing the size of two of said first, second and third components which are smaller than the largest of said components to match said larger component.

20. An image generation apparatus as claimed in Claim 19, wherein said image generator has a light source which is arranged in operation to be modulated in accordance with said colour image, and said image generation apparatus comprises an imaging lens means configured in operation to focus the modulated light on to a screen, wherein said imaging lens is arranged in operation to generate control signal indicative of an amount by which said two smallest components differ from said largest component, and said image processing apparatus is arranged in operation to receive said control signal, which is representative of a chromatic aberration error of said lens, said image processing apparatus being arranged in operation to correct said

error by said matching of said two smallest components to said largest of said components.

21. An image processing method comprising the steps of

- receiving a colour image signal representative of a colour image, said colour image signal comprising first data representative of a first image component of light having at least one first wavelength and second data representative of a second image component of light having at least one second wavelength, wherein the sizes of said first and said second image components differ with respect to each other, and said method comprises the steps of

- processing the first or the second data corresponding to the smaller of the first and second image components to the effect of increasing the smaller component consequent upon said difference in size to the effect that the content of said first and second components are substantially the same size.

22. An image processing method as claimed in Claim 21, wherein the difference in size is as a result of a difference in the area of said first and second image components with respect to a common reference area, and said method comprises the steps of

- determining which of said first and second components have the smaller area, and

- consequent upon a difference between the area of each of said smaller area and the larger area, the step of processing said first or said second data to increase the smaller component, has the effect of increasing proportionately said one of said first and second components of said colour image having the smaller area to the effect that the content of said first and second data are substantially the same.

23. An image processing method as claimed in either of Claims 21 or 22, wherein the step of increasing proportionately said smaller component comprises the step of

- interpolating said one of said first and second data corresponding to said smaller two of said first and said second components.

24. An image processing method as claimed in either of Claims 21, 22 or 23, wherein said first and said second data are representative of a number of lines from which said first and said second components of the colour image are composed, said interpolating being performed to increase the smaller of the two components to equal the largest component in accordance with said difference in said number of lines.

25. An image processing method comprising the steps of

- receiving a colour image signal representative of a colour image, said colour image signal comprising first data representative of a first image component of light having at least one first wavelength, second data representative of a second image component of light having at least one second wavelength, and third data representative of a third image component of light having at least one third wavelength,

wherein the sizes of said first, second and third image components differ with respect to each other, and said method comprises the steps of

- processing two of the first, second and third data to the effect of increasing the smallest of the two of the first, second and third image components consequent upon said difference in size to the effect that the content of said first, second and third components are substantially the same.

26. An image processing method as claimed in Claim 25, wherein the difference in size is as a result of a difference in the area of said first, second and third image components with respect to a common reference area, and said method comprises the steps of

- determining which two of said first, second and third components have the smallest areas, and

- consequent upon a difference between the area of each of said smallest areas and the largest area, the step of processing said two of said first, second and third data to the effect of increasing the smallest two components, has an effect of increasing proportionately said two of said first, second and third components of said colour image having the smallest areas to the effect that the content of said first, second and third data are substantially the same.

27. An image processing method as claimed in either of Claims 25 or 26, wherein the step of increasing proportionately said two components comprises the step of

- interpolating said two of said first, second or third data corresponding to said smallest two of said first, second and third components.

28. An image processing method as claimed in Claims 25, 26 or 27, wherein said first, second and third data are representative of a number of lines from which said first, second and third components of the colour image are composed, said interpolating being performed to increase the smaller of the two components to equal the largest component in accordance with said difference in said number of lines.

29. An image processing method as claimed in any of Claims 25 to 28, comprising the steps of

- receiving said first, second and third data,

- receiving a control signal indicative of a relative size of said first, second and third components of said colour image, and

- determining an amount by which said two smallest of said first, second and third components differ with respect to the largest of said image components, before the step of processing two of said first, second and third data corresponding to said two smallest components by interpolating said data representative of said two smallest image components.

30. An image processing method as claimed in any of Claims 25 to 29, wherein said first, second and third image components correspond substantially to red, green and blue light components.

31. An image processing method comprising the steps of

- focusing an image formed within a field of view of an imaging lens on to a dichroic separator means or a colour filter means,

- separating said image using said separator means into red, green and blue components,

- sampling said red, green and blue light components to generate first, second and third data representative of said red, green and blue components respectively,

- determining a difference in the size of said red, green and blue components, and compensating for said difference by applying the steps of the image processing method claimed in Claim 19.

32. A method of generating an image, comprising the steps of

- generating red, green and blue light components of a colour image,

- focusing said red, green and blue components using an imaging lens on to a screen, wherein the step of generating said red, green and blue light components comprises the steps of

- determining a difference in the size of said red, green and blue components of said colour image caused by said imaging lens,

- determining which two of said red, green and blue components have the smallest areas, and

- consequent upon a difference between the area of each of said smallest areas and the largest area,

- processing two of said red, green and blue components to the effect of increasing proportionately the smallest two components of said colour image having the smallest areas to the effect that the content of said red, green and blue components are substantially the same.

33. An image processing apparatus arranged in operation to receive a colour image signal representative of a colour image, said colour image signal comprising

- first data generated from a first colour component of said image having light of at least one first wavelength, and

- second data generated from a second colour component of said image having light of at least one second wavelength, said image processing apparatus comprising

- a control processing means arranged in operation

- to determine an amount by which the content of said first and second data differ as a result of the first and second image components being different in size, and said first and second data being generated with respect to a common reference, and

- a data processing means coupled to said control processor, which is arranged in operation

- to process said first data or said second data corresponding to said larger component to reduce said first data or said second data in accordance with said difference in size, and

- to repeat part of said first or said second data corresponding to said larger component in correspondence with an amount by which said larger component has been reduced.

34. An image processing apparatus as claimed in Claims 33, wherein the difference in size is represented as a difference in the area of said first and second image components, said first and second data being generated with respect to a common reference area.

35. An image processing apparatus as claimed in Claims 33 or 34, wherein said apparatus is arranged in operation

- to receive a control signal indicative of which of said first and said second image components is larger in size, and said control processor determines from said control signal which of said first and second image components is larger in size and the amount by which said first and second components is larger in size.

36. An image processing apparatus as claimed in any of Claims 33 to 35, wherein said first and said second data are representative of a number of lines, said difference in said sizes of said first and second components corresponding to a number of lines by which said first and second components of the image differ.

37. An image processing apparatus as claimed in Claim 36, wherein said data processing means operates to reduce said first or said second data by decimating said data, whereby said number of lines is reduced.

38. An image processing apparatus as claimed in any of Claims 33 to 37, wherein said repeated data is the first and last line at edges of said image component, said first

and last line being repeated in correspondence with the number of lines by which said larger component has been reduced.

39. An image processing apparatus as claimed in any of Claims 33 to 38. wherein said colour image signal comprises

- third data representative of a third colour component of said image having light of at least one third wavelength, the size of said third component differing from said first and second image components, and consequent upon said difference said image processor is arranged in operation

- to process said third data to the effect that said first, second and third components have substantially the same content.

40. An image processing apparatus as claimed in Claim 39, wherein said image processor is arranged in operation to process said third data to the effect of;

- changing the size of said third image component by increasing proportionally the size of said third component if said third image component is smaller than at least one of said first and second components by interpolating said third data corresponding, or

-changing the size of said third image component by reducing proportionally the size of said component if said third image component is larger than at least one of said first and second components by decimating said third data correspondingly, and selectively repeating part of said third data to the effect of making the content of said match that of the smaller of said first and said second components.

41. An image processing method comprising the steps of

- receiving a colour image signal representative of a colour image, said colour image signal comprising first data generated from a first colour component of said image having light of at least one first wavelength, and_second data generated from a second colour component of said image having light of at least one second wavelength,

- determining an amount by which the content of said first and second data differ as a result of the first and second image components being different in size, and said first and second data being generated with reference to a common reference, and

- determining which of said first and second data is representative of a larger of said first and second components having lesser content as a result of being larger in size, and

- processing said first data or said second data corresponding to said larger component to reduce said first data or said second data in accordance with said difference in size, and

- repeating part of said first or said second data corresponding to said larger component in correspondence with an amount by which said larger component has been reduced.

42. An image processing method as claimed in Claims 41, wherein the difference in size is represented as a difference in the area of said first and second image components, said first and second data being generated with respect to a common reference area.

43. An image processing method as claimed in Claims 41 or 42, comprising the step of

- receiving a control signal indicative of which of said first and said second image components is larger in size, and said control processor determines from said control signal which of said first and second image components is larger in size, and the amount by which said first or said second components is larger in size.

44. An image processing method as claimed in any of Claims 41 to 43, wherein said first and second data are representative of a number of lines, said difference in said sizes of said first and second components corresponding to a number of lines by which said first and second components of the image differ.

45. An image processing method as claimed in Claim 44, wherein the step of processing to reduce said first or said second data, comprises the step of decimating said data. whereby said number of lines is reduced.

46. An image processing method as claimed in any of Claims 41 to 45, wherein the step of repeating part of said first or second data, comprises repeating the first and last line at edges of said image component, said first and last line being repeated in correspondence with the number of lines by which said larger component has been reduced.

47. An image processing method as claimed in any of Claims 41 to 46, wherein said colour image signal comprises

- third data representative of a third colour component of said image having light of at least one third wavelength, the size of said third component differing from said first and second image components, and said method comprises the step of

- processing said third data to the effect of changing, consequent upon said difference, the size of the third component to the effect that said first, second and third components have substantially the same content.

48. An image processing method as claimed in Claim 47, comprising the steps of

- processing said third data to the effect of

- changing the size of said third image component

- by increasing proportionally the size of said component when said third image component is smaller than at least one of said first and said second components by interpolating said third data correspondingly, or

- by reducing proportionally the size of said component when said third image component is larger than at least one of said first and second components by decimating said third data corresponding.

49. An image processing apparatus as claimed in any of Claim 33 to 40, wherein said first, second and third image components correspond substantially to red, green and blue light components.

50. A camera comprising an imaging lens, and an image processing apparatus as claimed in Claim 49, wherein said imaging lens is arranged in operation to generate first, second and third signals representative of the red, green and blue components of a colour image formed within a field of view of said imaging lens, and said image processing apparatus is arranged in operation to receive said first. second and third signals, and to process said signals to the effect of reducing the size of two of said red, green and blue components which are larger than the larger two of said components to match substantially the content of said largest component.

51. An image generation apparatus, comprising an image generator configured in operation to generate first, second and third data representative of red, green and blue components of a colour image, and an image processing apparatus as claimed in Claim 49 arranged in operation to receive said first, second and third data, and to process said data to the effect of reducing increase the size of two of said red, green and blue components which are the two larger of said components to match said largest component.

52. An image processing apparatus as herein before described with reference to the accompanying drawings.

53. A camera as herein before described with reference to the accompanying drawings.

54. An image generation apparatus as herein before descried with reference to the accompanying drawings.

55. An image processing method as herein before described with reference to the accompanying drawings.

56. A computer program providing computer executable instructions, which when loaded onto a computer configures the computer to operate as an image processing apparatus as claimed in any of Claims 1 to 14, and 33 to 40.

57. A computer program providing computer executable instructions, which when loaded on to a computer causes the computer to perform the method according to Claims 21 to 31, and 41 to 48.

58. A computer program product having a computer readable medium recorded thereon information signals representative of the computer program claimed in any of Claims 56 or 57.

The Patent Office

PATENTS • DESIGNS • COPYRIGHT • TRADE MARKS

INVESTOR IN PEOPLE

Application No: GB 0007937.6
Claims searched: 1 to 32

Examiner: Trevor Berry
Date of search: 24 October 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): H4F (FCCF, FGB, FGC, FHA, FHHX)

Int Cl (Ed.7): H04N

Other: ONLINE: EPODOC, JAPIO, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	EP 0595301 A2 MATSUSHITA-note column 5 lines 44-56	At least 1 and 21
A	EP 0350794 A2 HITACHI	

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
& Member of the same patent family
A Document indicating technological background and/or state of the art.
P Document published on or after the declared priority date but before the filing date of this invention.
E Patent document published on or after, but with priority date earlier than, the filing date of this application.